DOCUMENT RESUME

ED 062 821 EM 009 889

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TITLE A Cognitive Approach for Instructional Media Research.
INSTITUTION City Univ. of New York, N.Y. York Coll.
PUB DATE Apr 72
NOTE 19p.; Paper presented at the Association for Educational Communications and Technology Annual Convention (Minneapolis, Minnesota, April 16-22, 1972)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS Achievement Tests; *Cognitive Measurement; *Cognitive Processes; Concept Formation; *Educational Research; Identification; Instructional Media; Learning Characteristics; Learning Theories; *Problem Solving; *Success Factors

ABSTRACT

The history of instructional media research is marked by an emphasis on the use of the terminal performance to measure learning. Little attention has been paid to the processes of learning. However, some studies have identified cognitive strategies used in solving problems of concept identification. The task now is to find out the relationship of strategy used and the terminal performance. Preliminary studies have shown that subjects use all of the following six strategies in solving three concept problems: successive scanning, conservative focusing, focus gambling, start-over, multiple, and ambiguous strategies. It appears that increase of the use of the conservative focusing and successive scanning strategies are in direct relationship with the overall performance. But conclusive statements about this are premature, since no direct relationship was found between the overall performance and the use of each strategy. What is significant is that it is experimentally possible to use the type of strategies employed by subjects as another dependent variable in this problem. (JK)

ED 062821

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A COGNITIVE APPROACH FOR INSTRUCTIONAL MEDIA RESEARCH

by

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Presented at the National Convention of the Association for Educational Communications and Technology in Minneapolis, Minnesota.
April 1972

EM 009 889

A Cognitive Apprcach for Instructional Media Research

Introduction

The phenomenon of learning may be explained in terms of the terminal performance and in terms of the processes in learning. The history of instructional media research is marked by an emphasis on the use of the terminal performance to measure learning and has given little or no experimental attention to the processes in learning.

Since the same terminal performance may come about by different cognitive processes (Luchin, 1961), it is unlikely that a theory of instructional media can be constructed if media research never goes beyond the boundary of considering responses alone. The cognitve processes in learning deserve at least as much research attention as the terminal performance of learning, if not more.

Possibly, the lack of research attention has reflected a lack of research techniques by which the mental processes may be studied. This paper is to consider an approach which may be used to investigate, and presumably externalize the mental processes and at the same time take into consideration the terminal performance of learning.

The proposed approach is called a cognitive approach which is used in this paper to refer to the psychological inquiries into the mental processes as exemplified by the investigation of strategies (Seymour, 1954; Bruner, Goodnow, and Austin, 1956) used by S in the course of learning. An experiment designed to investigate the selection and utilization of cognitive strategies in concept identification will be used to illustrate how the proposed approach may be used to investigate the cognitive processes in media research.

Problems Not Yet Investigated in Instructional Media Research

One area has always been avoided by the investigators of instructional media, that is, the cognitive processes in learning.

Instructional media research from its inception through the 1950's was mainly of media comparision in nature, that is, to compare film with television, television with conventional methods. There was hardly any attempt at all to investigate the cognitive processes in learning. For example, in 320 studies conducted between 1918 and 1958, none were concerned with problems relating to the cognitive processes (Allen, 1960). Although media research shifted away from employing media per se as variables and became more analytical in the 1960's, the cognitive processes remained not a topic of investigation. The statistics show: in 407 studies reviewed by Lumsdaine and May (1965), 165 studies analyzed by Briggs, Campeau, Gagné and May (1967), 292 studies summarized by Chu and Schramm (1967), none dealt with the cognitive processes. This phenomenon was also reflected in doctoral studies: in 710 dissertations written for doctoral degress in instructional media, none investigated the cognitive processes (Moldstad, 1956, 1958, 1959, 1961). Recent reports (Allen, 1971; Carpenters,1971) indicate that this phenomenon remains unchanged. The question then is: can media researchers afford to ignore investigation of the cognitive processes in learning?

Can Instructional Media Research Continue to Avoid Investigation of the Cognitive Processes?

The answer to this question is obviously a negative one. Although there has been no reported experimental studies on the cognive processes by media researchers, the significance of studying them has been recognized by some reseachers.

In 1961, a group of distinguished psychologists of learning were invited by AV Communication Review, the reseach journal of the Association for Educational Communications and Technology (then called the Department of Audiovisual Instruction) to give their views on the possible applications of psychological theories to the problems of audiovisual education. Luchins (1961), one of the psychologists invited, argued that media researchers, in their attempts to construct a theory of instructional media, must take into consideration the cognitive processes in learning. The reason, he said, was simply this; because the same outcomes (responses) might come about through different processes and that some processes could be better than others. He suggested that instructional media research should explore the cognitive processes in learning in order to provide theoretical foundations for developing new audiovisual devices. It has been more than a decade since Luchins made these recommendations. But as of today, almost no effort has been made to investigate the cognitive processes by media researchers.

Being aware of a lack of research attention in the cognitive processes, Allen (1970), in his attempt to categorize instructional media research, pointed out that the psycho—physical processes operating in learning were areas which researchers must deal with. Although he was not clear, as he admitted, as to the precise maeaning of the psycho-physical processes, his concern was clearly the cognitive processes in learning and how they might be affected by or related to media. Sharing this view, though not derived from it, Salomon (1970) proposed a cognitive-functionalistic approach as a possible strategy to enter the "black box".

In order to lay foundations for a theory of instructional media, in the opinion of Salomon, media research instead of concerning itself with immediate application, should focus on inquiries into the psychological functions which

one medium is or is not capable of arousing, and define media accordingly. These are his own words:

> I propose, therefore, that we define an instructional media as the interaction of two variables: physical similarity of psychological functions, i.e., an instructional medium is a package of unique modes of presenting information (which may or may not be a consequence of some attributes of machines) which also fulfills a unique psychological function. (Salomon, 1970, p.38)

According to the classification scheme outlined above, if the pictures, whether they be on a printed page, or on the television screen, or in a film, fulfill the same psychological functions, then they should be categorized as one instructional medium. If not, they should be treated as different media.

The psychological functions that media could fulfill, as reported by Salomon (1970) and others (Salomon and Snow 1968), were arousal, supplantation and reinforcement of S's mental processes either to compare, relate, identify, or other mental activities. The question then is, how do we know whether his mental processes in the course of learning are those of comparing, relating, identifying, etc.? In other words, how do we know what goes on in one's mind?

A Cognitive Approach for Instructional Media Research

The question just raised in the previous paragraph has been a topic of psychological inquiry for centuries. The most commonly used experimental technique for studying the mental processes has been S's verbal report of what goes on in his mind. A classical example was Heidbreder's (1924) experimental study on thinking. She instructed her Ss to report verbally how they solved each problem. Bruner, Goodnow, and Austin (1956) in a series of studies on concept identification asked their Ss to state hypotheses which were formulated on each trial. Also while investigating problems on

concept identification tasks, Bourne (1963) asked his Ss to respond to each concept instance with a verbal statement of his hypothesis about the concept presented.

Instead of reporting what went on in one's mind,some experimenters required S to ask questions leading to a solution for the problems presented to him. For example, Mosher (1963),in an experiment designed to investigate the cognitive strategies used in the course of solving concept problems, employed a question-asking technique, similar to the game of Twenty Questions. On being presented with an array of pictures, S was asked to find out the solution for each concept problem by asking any questions to which E simply gave a "yes" or "no" answer. By the nature and sequence of the questions asked, he was identified as using such strategies as constraint, hypothesis scanning, pseudo-constraint, or simply guessing.

The technique of using verbal statement to identify the cognitive processes has at least one shortcoming: the possibility of S's inability to vocalize what actually went on in his mind. Psychologists attempting to study the cognitive processes have been troubled, until recently, with this problem,and have often been accused of resorting to introspection. To remedy this problem, some psychologists (for example, Reitman, 1965; Simon and Newell, 1971) have used computers to simulate thinking processes; and other psychologists have instead employed blank trial technique (Levine, 1963, 1966) which will be described later.

As was pointed out earlier, instructional media research has not addressed itself to the problems of mental processes, but has measured learning primarily in terms of dependent variables that are terminal performance in nature, The most commonly used dependent variables in media research have been: (a) speed of response, (b) number of trials, (c) number of

correct responses, and (d) number of errors that was required of S to complete a task in experimental studies, and (e) frequency counting of S's selection of answers from a numerical scale used mostly in questionnaires.

These dependent variables were used singly or in combination, in virtually all media studies, regardless of whether the nature of investigation was media comparison, utilization studies or basic studies and regardless of whether the type of media investigated was television, motion pictures, overhead transparencies, or whatever (Briggs et al., 1967). One of the recent examples is: the mean number of correct responses was used as a dependent variable to measure S's performance in a study designed to investigate the effects of color versus black-and-white visual materials on learning, opinion, and attention (Katzman and Nyenhuis, 1972). In this experiment, Ss were asked to respond to color slides and black-and-white slides. The results showed that S's recall of peripheral visual materials was significantly better under the black-and-white conditions, and the hypothesis that color increased S's liking for and attention to the visual materials presented was not substantiated.

The report on the results of this experiment exemplifies how media researchers record their findings.

Generally speaking, whatever the independent variables are, the results are always stated in such a way that S's performance, which is almost always measured by one or more of the dependent variables described previously, either significantly improves or deteriorates under one experimental condition or another, or thereis no significant difference between the two. Investigators then offer, as a rule, their interpretations as to how this significant difference, positively or negatively, or this no-significant difference, might have resulted. One type of interpretation has not

been attempted by media researchers, that is, from the viewpoint of cognitive strategies used by S in the course of learning.

Seymour (1954) and Bruner et al. (1956) have identified four cognitive strategies employed by S in solving concept identification problems. These four strategies were the simultaneous scanning strategies, the successive scanning strategy, the conservative focusing strategy and the focus gambling strategies. In addition to these four strategies, it has been reported by subsequent experiments that there were other strategies used by S as well. Bourne (1963), in a study designed to investigate strategy utilization, found that S utilized mainly two strategies to solve concept problems, These two strategies were the wholist focusing strategy and the partist scanning strategy; the users of the wholist strategy were those who attended all attributes simultaneously and the users of the partist strategy were those who attended some of the attributes contained in any concept instances. The results showed that the wholist focusing strategy was superior to the partist scanning strategy in terms of S's overall performance.

Investigating the possible relationship between the use of strategies and learning set in concept attainment, Byers (1963) reported that among 18 possible strategies which he identified in terms of the sequence of visual selection and numerically labeled St_1, St_2 and up to St_{18}, S adopted consistently the low risk strategies, which, in rank order, were St_1, St_7, and St_2.

Similarly, Peterson (1964) also reported S's preference of certain strategies over others in her experiment designed to investigate the development of strategies at various stages of learning. Eight strategies labeled St_{all}, St_1, St_2, St_1, St_{11} St_R, St_{RR} and St_E were identified according to the manner and sequence of S's selection of stimulus materials. The results demonstrated that S by and large preferred St_{all} over other strategies. St_{all}

was approximately equivalent to the wholist strategy of Bruner et al. (1956) and Bourne (1963). S's preference of St_{all} to other strategies was probably due, according to Peterson, to the amount of information it rendered was greater than other strategies.

From the studies on strategies just cited above, it is clear that the cognitive strategies vary in efficiency. Earlier, it was pointed out that S's overall performance improves or deteriorates according to the experimental conditions.

Given these two lines of empirical evidence, the question arises as to whether the efficiency of strategies employed in the course of learning increases as the overall performance improves, or decreases as the overall performance deteriorates. The assumption, based on empirical evidence presented above is that there is a relationship between types of strategy utized and the overall performance.

To investigate this assumption, it is necessary to use both the overall performance and strategies as dependent variables.

As the measurement of overall performance in media studies was already described previously, now only the use of strategies as a dependent variable needs elaboration.

In the following I shall describe how strategies may be identified using concept identification problems as an example.

Identification of Strategies

Stimulus materials, used in concept identification problems, usually consist of several dimensions, each having several values. Suppose that there are three dimensions having three values associated with each dimension: color dimension has the values of red, green and black; shape dimension has

the values of crosses, circles, and squares; and number dimension has the values of one, two, and three. Further assume that each concept instance exhibits one value from each dimension. Some sample instances are "one green square" (1G□), "two black circles"(2BO), and "three blue crosses" (3B+). A permutation of three dimensions and three values associated with each dimension produces 27 concept instances.

In terms of this stimulus parameter, the instance selected on Trial N and the one selected on Trial + N may differ by: (a) zero (repeated selection of instance), (b) one, (3) two, or (d) three elements. For example, if 1G□ (one green square) is selected on Trial N, then the instance selected on Trial N + 1 must be one of these four types. They are shown in Table 1.

Table 1

NUMBER OF ELEMENTS CHANGED BETWEEN TRIAL N and N + 1

Trial N	Elements Changed	Trial N + 1						
1G□	0	1G□ *						
	1	1G+	1GO	1B□	1R□	2G□	3G□	
	2	1B+	1BO	1R+	1RO	2G+	2GO	2B□
		2R□	3G□	3GO	3B□	3R□		
	3	2B+	2BO	2R+	2RO	3B+	3BO	3RO
		3R□						

* G : Green □: Square +: Cross O: Circle

It was mentioned earlier that to remedy the possibility that S may not be able to articulate what goes on in his mind, Levine (1963, 1966) has developed a blank trial technique to trace experimentally defined strategies (or hypotheses in his terminology). He demonstrated that when no feedback followed response, then S kept the same strategies for next trial and thus it was possible to trace the strategies employed during the nonfeedback trials. This was done by interpolating feedback trials between block of nonfeedback trials. Levine refered the nonfeedback trial as the blank trial. Use of the blank trial technique to infer strategies has been reported by subsequent studies (for example, Peterson, 1964; Frankel, Levine, and Karpf, 1970).

Let us assume that trial N is a feedback trial and Trials N + 1, N + 2, and N + 3 are a series of three consecutive blank trials. Since S, as demonstrated by Levine (1963, 1966), keeps the same strategies for next trial when no feedback is given on the preceeding trial, it is then possible to identify strategies which he employes in the course of solving concept problems. This can be done by comparing the number of elements that are changed between the feedback trial (i.e., Trial N) and each of the three nonfeedback trials (i.e., Trials N + 1, N + 2, and N + 3). This is diagramatically illustrated in Fig. 1. All 27 instances are categorized into four groups which are labelled 0,1,2, and 3, according to the number of elements that are changed between Trial N and Trial N + 1.

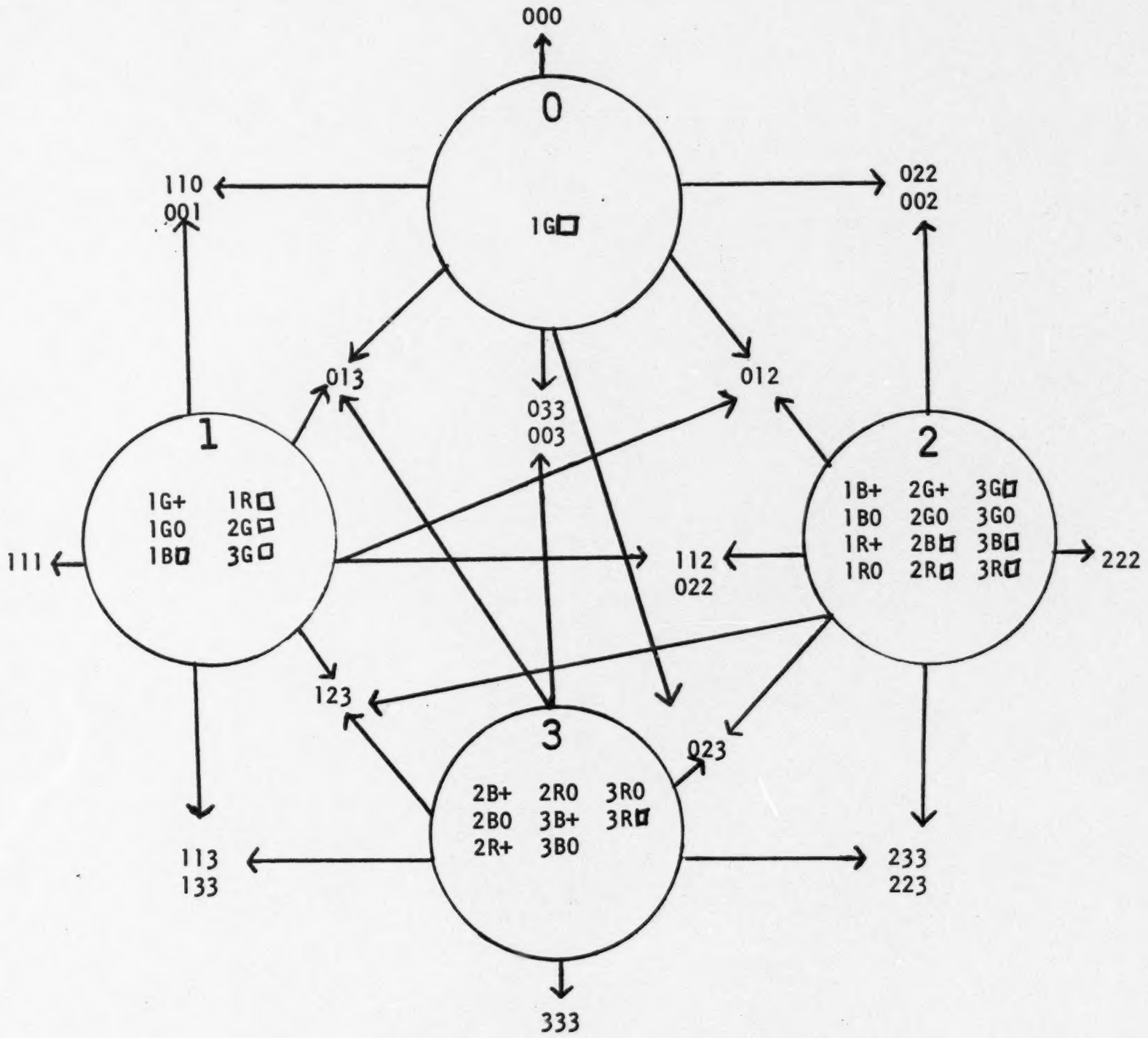

Fig. 1. Schematic Representation of Identification of Strategies.

Mathematically, there are twenty possible combinations of the four groups of instances, taking three instances at a time. As shown in Fig. 1, the twenty response patterns generated from these four groups are identified as 111, 112, 113, 011, 222, 122, 223, 022, 333, 133, 233, 033, 000, 001, 002, 003, 123, 012, 013, and 023.

S's responses on any three consecutive blank trials must be one of these twenty patterns. Strategies are identified from these response patterns as follow:

Conservative focusing strategy: If at least two of the three instances on the blank trials change only one element from the instance on the immediately preceding feedback trial, then S is identified as using the conservative focusing strategy. These include the response patterns of 111, 112, 113, and 011.

Focus gambling strategy: If at least two of the three instances on the blank trials change two elements from the instance on the immediately preceding feedback trial, then S is identified as using the focus gambling strategy. These include the response patterns of 222, 122, 223, and 022.

Start-over strategy: If two or more instances on the blank trials change all three elements from the instances on the immediately preceding feedback trial, then S is inferred to be using the start-over strategy. These include the response patterns of 333, 133, 233, and 033.

Multiple strategy: If all three instances on the blank trials change different number of elements, that is, zero, one, two, or three, from the immediately preceeding feedback instance, then S is identified as utilizing the multiple strategy. It is so called because he employes the conservative focusing strategy for one selection, the focus gambling strategy for still another selection. These include the response patterns of 123 and 012.

Ambiguous strategy: If S repeatedly chooses more than twice the immediately preceding feedback instance on the blank trials, then he is identified as utilizing the ambiguous strategy. It is so called because there is no apparent information gained for S by choosing the very same instance again. In other words, he gains no information from such a choice with respect to the problem in question. These include the response patterns of 000, 002, 003 and 001.

Successive scanning strategy: If S's response patterns on the blank trials satisfy either one of these two requirements, then he is identified as using the successive scanning strategy: (a) If on any one single feedback trial and its subsequent set of three consecutive trials S selects different instances but consistent in one element, or (b) If on any two or more adjacent feedback trials and each of their subsequent sets of three consecutive blank trials, S selects instances consistent in one element with at least four distinctively different instances. (For more information, see Huang, 1970).

The purpose of this paper is, as was described in the beginning , to suggest an approach which, in addition to using the overall performance to measure learning, will take into consideration cognitive strategies utilized in the course of learning. One of the difficulties arising from studying the cognitive strategies has been a lack of proper experimental techniques. What was described above regarding how strategies might be identified should enable media researchers to employ type of cognitive strategies as another independent variable .

To test the assumption that there was a correlation between the type of strategies utilized and the overall performance, Huang (1970) conducted an experiement using both strategies and overall performance as dependent

variables. The overall performance was measured by the mean number of trials for solutions and the cognitive strategies were inferred by using the scheme of strategies identification outlined above. Stimulus materials used were those 27 instances described previously. They were made on 2 X 2 slides and were presented for Ss by an electronically controlled display box. Their tasks were to solve three concept problems.

It was found that in the course of solving the three concept problems, Ss employed all six strategies described above, namely, successive scanning, conservative focusing, focus gambling, start-over, multiple, and ambiguous strategies. The data further showed that a majority of Ss utilized the conservative focusing strategy and the successive scanning strategy. For the first, second, and third problems, these two strategies scored, respectively, 80.70%, 84.69% and 89.23% of all strategies identified. The difference was statistically significant. However, no significant difference was found for either strategy when each strategy was computed independently. Neither there was a significant difference for the focus gambling, start-over, multiple or ambiguous strategy.

It was further reported that the overall performance, as measured by the mean number of trials for solutions, also improved significantly from the first problem to the second problem and from the second problem to the third problem.

The data on strategy utilization and overall performance seemed to indicate that the increase of the use of the conservative focusing strategy and the successive scanning strategy was in direct relationship with the overall performance. Fig. 2 shows graphically this relationship.

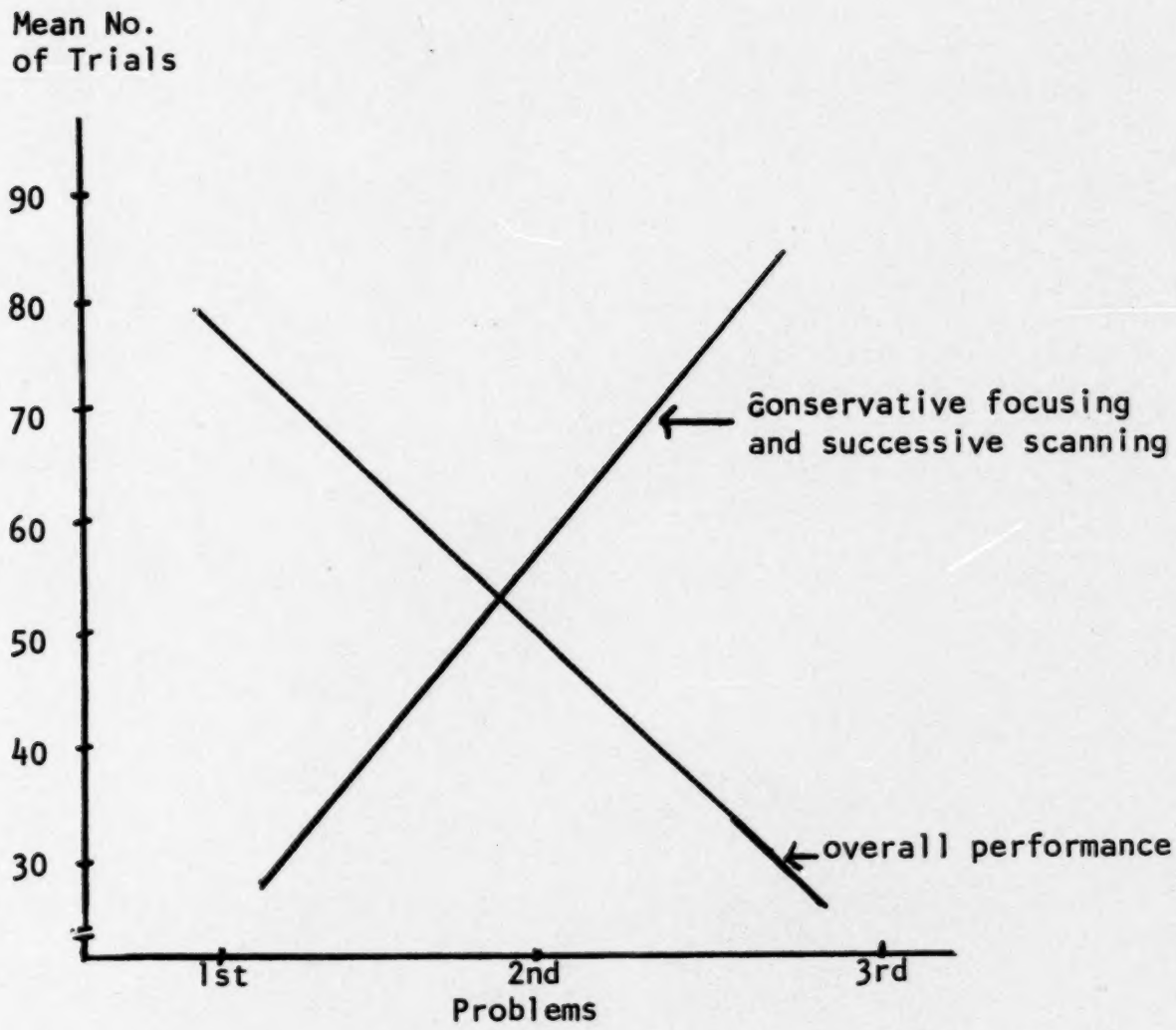

Fig. 2 Mean number of Choices for Criteria Under Each Problem Type

However, since no direct relationship was found between the overall performance and the use of each of the six strategies identified in this experiment , conclusive statements about the correlation between the overall performance and strategy utilization are premature. What seems significant is that it is experimentally possible, as demonstrated in this study, to use the type of strategies employed by S as another dependent variable.

Concluding Remarks:

It was pointed out in the beginning that since the same response of learning may come about, as argued by Luchin (1961), through different cognitive processes, it is highly unlikely that a theory of instructional media can be constructed at all if media investigators are ignorant of the cognitive processes leading to the response. Nevertheless, media research has long ignored investigation into the cognitive processes.

The lack of experimental techniques by which the cognitive processes could be investigated was in part responsible for the lack of research attension. The cognitive approach that was illustrated in this paper is an attempt to bridge the gap and should enable media researchers to explore the long-ignored cognitive processes in media research. Coupled with the conventional method of measuring S's learning, i.e., overall performance, the proposed approach could also open up paths for fruitful research on the previously-raised question as to whether the efficiency of strategies employed in the course of learning increases as the overall performance improves, or decreases as the overall performance deteriorates.

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